Information Taxonomy for Presentation, Selection and Design

Syndicate 5

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ABSTRACT

This report contains the ideas shared during our syndicate sessions. We tried to use these few hours of brainstorming to come up with guidelines about how to improve future visualization techniques to address military issues. The results of our discussions consist of a) advice on how the industry, the research community and user representatives should work together to best serve the military needs, b) a preliminary look at how sensors and weapons capabilities, performance and constraints could be presented, c) additional areas of research that were identified while considering military issues, and d) some guidelines about how to evaluate a visualization tool.

1.0 ADVICE ON WORK PROCESS

Considering the urgency and the complexity of the military needs for visualization tools, we concluded that both trial-and-error quick prototypes and longer term research to solve hard problems are equally important. Rigorous research is obviously necessary to tackle the many hard problems in presenting just what the users need to perform theirs task. However, systems should be put in the users' hands as quickly as possible. Fast-prototyping and trial and error are appropriate methods for this task since the users' needs will change as they get to interact with the tools. Users are crucial in the development loop since someone has to be very knowledgeable about the domain to know what elements of information need to be presented. A related fact mentioned was that a lack of representative data often ends up being a serious bottleneck in the development process of visualization tools. Hence, regular exchange points need to be scheduled between industry, research community and military personnel in order to exchange needs, views and results. This would also help to get the different parties to talk the same language and work in a way that would minimize redundancy and facilitate integration.

Paper presented at the RTO IST Workshop on "Massive Military Data Fusion and Visualisation: Users Talk with Developers", held in Halden, Norway, 10-13 September 2002, and published in RTO-MP-105.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
00 APR 2004	**N/A**	**-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Information Taxonomy for Presentation, Selection and Design Syndicate 5	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Halden Norway**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

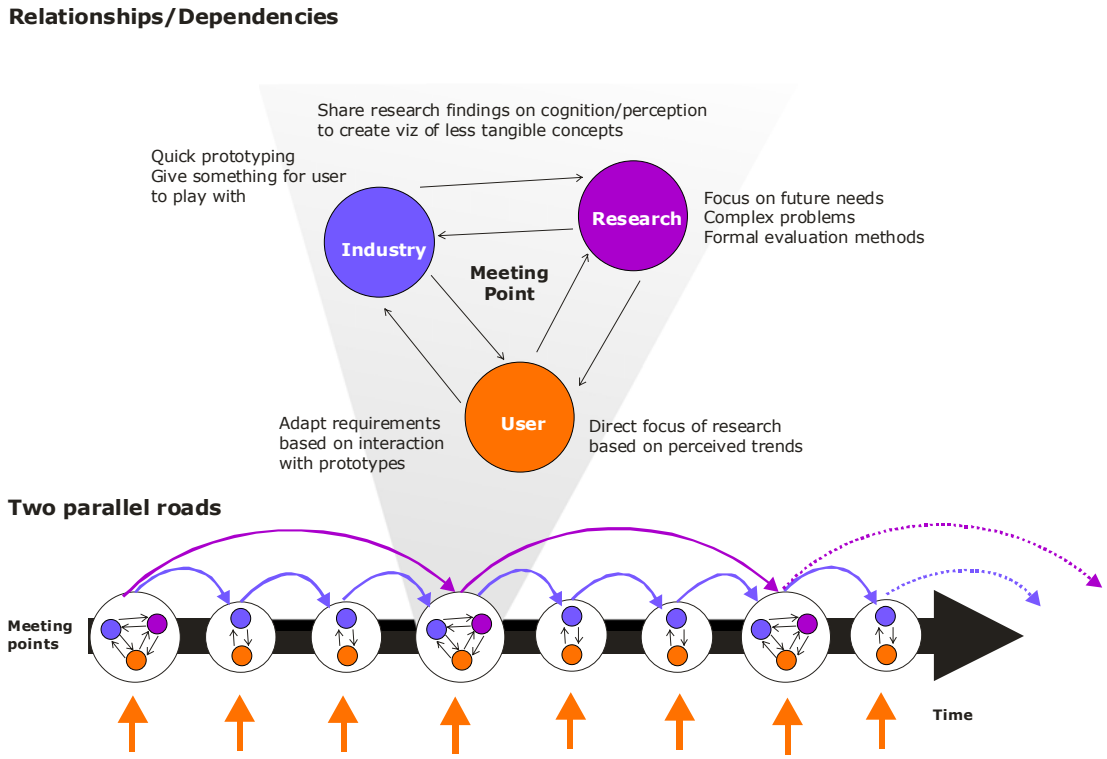
13. SUPPLEMENTARY NOTES
See also ADM001665, RTO-MP-105 Massive Military Data Fusion and Visualization: Users Talk with Developers., The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**17**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18



2.0 PROCESS ILLUSTRATION (How We Came to Choose Our Topic)

The keynotes speakers strongly communicated their need for a better common operational picture (COP). The first step for our syndicate was then to define which elements of information should be presented to satisfy this need.

Our user representative produced a list of elements of interest. An attempt at mapping visualization approaches to the different elements of information in the domain context brought to the foreground the challenge of not only dealing with huge amount of physical information, but also the need to extract much **less tangible information**, such as 'intentions', 'uncertainties', 'threats', 'operational readiness', etc.

Another point that was emphasized by the user representatives during this workshop is the fact that in the new higher tempo kind of warfare, higher-level decision-makers are more likely to be faced with very little time to make very difficult decisions. It follows that to be useful in that kind of critical situation, the COP needs to provide more than situation awareness: it needs to become more of a decision aid.

The challenge consists in reducing latency in the decision cycle by creating visualizations that emphasize 'actionable' information.

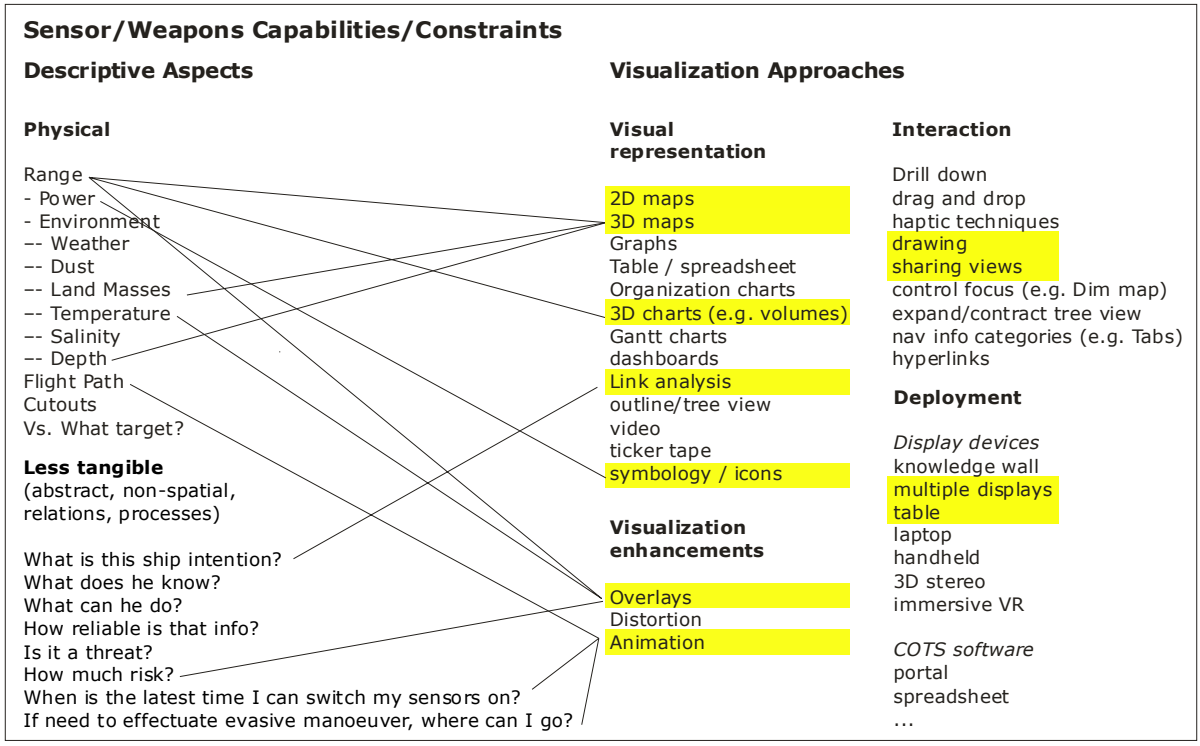
Based on our user representative area of expertise and knowledge of what is currently poorly done, we narrowed our focus to look at possible ways to visualize sensor and weapon capabilities and constraints. Furthermore, we decided to look at how decision points and timelines could be extracted from these visualizations based on movement and dynamics of the situation.

3.0 DOMAIN CONTEXT FOR PRESENTATION TECHNIQUES NEEDS

The issue of choosing the right visualization approach to present particular elements of information caught the interest of this syndicate.

The work of the TTCP C3I Action Group on Information Visualization (AG-3) presented by Denis Gouin during this workshop is a good start at tackling this issue. Part of that effort was the creation of a toolkit which queries databases to find the visualization tools supporting a specific analysis task. It would be beneficial for the visualization community to produce or gain access to such databases in order to facilitate the creation of an infrastructure/framework for the domain.

Our initial attempt (far from complete) to map visualization techniques to the elements of information needed for our selected topic is shown in the figure below. The visualization approaches listed in the diagram were taken from the paper Denis Gouin wrote for this workshop.



4.0 SELECTED TOPIC – SENSORS AND WEAPONS CAPABILITIES / PERFORMANCE / CONSTRAINTS

4.1 Present sensors and weapons (and communications) performance constraints showing 3D contours based on varying parameters values such as:

- **Environment (weather, terrain, salinity)**
- **Emission levels**
- **Probability of kill**
- **Countermeasures**
- **Time**

By showing the sensors and weapons volume coverage or range, what is not covered is also highlighted, which might be even more crucial in certain situations. Discontinuation of target tracking can then be predicted. Likewise, in a sensor network, the likely start of track reporting by own (firing quality) sensors can be predicted.

4.2 Showing target objects in relation to volume presentation – and volumes in relation to other volumes

As Battlespace volumes (performance constraints) of opposing platforms or forces approach each other, timelines and decision points can be extracted from presentation.

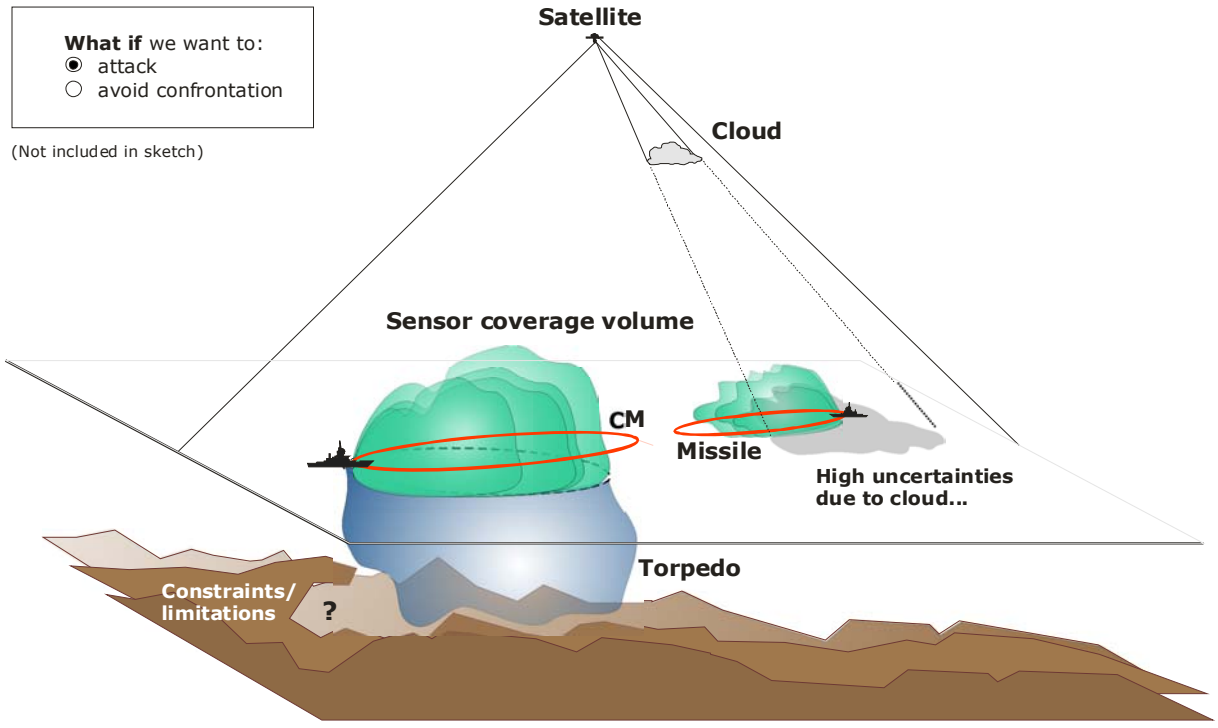
The view should allow users to answer questions at a glance like:

- What are the margins for detection of own platform/force based on the uncertainty regarding the constraints of **enemy sensors**?
- What are the margins for detection of enemy platforms/forces based on the uncertainty regarding the constraints of **own sensors**?
- When is the likely moment of first enemy hostile act?
- How reliable is the info about the other ship's location with respect to the constraints of my sensors?
- When is the latest time I can switch my sensors on in order to avoid early detection and to employ own weapons at their maximum capability?

The box at the top left of the sketch below illustrate the idea of listing possible decisions that could be analysed visually by selecting it. For example, choosing attack could overlay on the picture time, risk, etc. involved in that action.

4.3 Optimizing Volume Presentations

Volumetric presentations would convey the capabilities/constraints well, but experimentation is needed to be able to show complex intersecting volumes in a clear simple way as well as targets appearing in front of, inside of or behind volumes.



5.0 OTHER INTERESTING AREAS OF RESEARCH

5.1 Displaying Levels of Abstraction for Various Users

Different users at different levels of the military organization need different perspectives or level of details to accomplish their respective tasks. Furthermore, commanders might find it useful at times to look at what his or her subordinates see. Ideally, one tool would allow for continuous levels of abstraction.

The challenge is to create a set of rules that define how the elements of information can be aggregated when a simplified picture is needed.

5.2 Provide Alternate Modalities

One noticeable after effect of September 11 attacks is that the amount of information to be processed has increased dramatically. The information comes from multiple sources and in different forms (voice, chat, email, message, etc). Fusion needs to be applied to eliminate excess and redundancy, but without slowing the traffic too much since a lot of that information might be time sensitive.

It would be useful to find ways to level out the modalities used to process the information. The simple example brought up to explain the idea was your colleague writing 'Lunch time!' on a piece of paper and showing it to you while you are talking on the phone.

5.3 How "Real" is Necessary?

Comments from the user representatives such as "I want to see a helicopter, not a dot.", or "Resolution is never good enough." highlighted the question "How 'Real' is necessary?".

Obviously, it depends on the task. Realistic looking 3D models of airplanes might be attractive, but if, in order to recognize the type of aircraft, the models need to be so big that it becomes very hard to determine their altitude or relative distance, then it fails.

In this case, the challenge is to create simple icons that emphasize the crucial differences between the aircrafts that are used to tell them apart.

On the other hand, it was raised that the traditional military symbols need to be replaced because in the context of coalitions, language and cultural differences pose a serious problem.

SPAWAR developed the so-called 'Symbicons' to deal with that issue. At the time presented, they were rejected, but Col. Johansen suggested that they should try again, now that the need is more obvious.

Generally speaking, it would be useful to come up with guidelines defining when symbols/graphs work better than realistic representations.

5.4 Automatic Stress/Workload Detection

This provocative topic deals with the fact that under stress, humans have a tendency to narrow their focus and lose important context or big picture. The effect is called tunneling. It might be interesting to investigate if a system could automatically detect the level of stress and the cognitive load of the user and when those passes certain thresholds, the system would adaptively change the level of information being presented, forcing the user to pull back and look at the big picture again.

5.5 Automatic Display of Threats

This is another provocative suggestion that is partly based on Col. Johansen comment about the annoyance caused by the time it takes to put on the screen the particular view that is needed at a particular moment. He mentioned that when things are planned and most likely outcomes are known, the staff will setup the views that might be needed in advance. Maybe a system of bookmarks could be implemented to facilitate that solution.

With the assumptions that a system could automatically detect threats and know which views are needed to deal with them, then an alert could appear. Selecting it would display the right view to look at the threat. Unless the threat is much more crucial than the task at hand, it would probably be better to let the operator decide when to change what is shown on display.

6.0 EVALUATION/ASSESSMENT ISSUES

Finally, our syndicate also discussed the issue of assessing visualization systems. There is a need for metrics to assess its value. As mentioned above, the fact that 'the user likes it' might not necessarily be productive. Therefore here are a few guidelines that should be considered:

Go beyond the HAT report model –

This is needed because "cognitive walkthroughs" and comparable methods are NOT good predictors of usability in practice.

Elaborate on what the system is used for. Develop a representative sample of tasks.

Develop/agree upon measures of task performance, process as well as ultimate outcome.

If the system exists – Conduct experimental studies of users performing the sample tasks.

A reasonable number of users should be greater than ten.

The users involved in the experiment should get appropriate prior training before performance measurements.

If the system does not yet exist, but there is a design – Apply cognitive modelling to the sample of tasks (Card, Moran & Newell, Kieras & John).

This step may reveal that the task requirements cannot be met.

It also allows comparisons of alternative designs.

However, the scope of what can be modelled today is somewhat limited.

7.0 CONCLUSIONS

The sole fact that some results could be presented in this report should highlight the success of the syndicate concept with respect to having members of the different communities exchange data and views. This is a step in the right direction, but much more efforts need to be devoted to the creation of a solid infrastructure to support the creation of innovative visualization techniques that would effectively address the issues the military is faced with now and will be facing in the future.

SYMPOSIA DISCUSSION – SYNDICATE 5

Comment:
Recommend that there is effort and resources put into a decision tool that looks at resource distribution.

Comment:
In the NATO context, the political context is important to the common operational picture.

Question:
What impact can the three different domains - physical, information, cognitive domain (including moral, ethical, and political) – have on development of decision support tools?

Response:
Decision support tools can be applied in all domains, but analysis of the domains and requirements is need. Research is just in the beginning of defining those requirements. Focus right now is on the physical domain.

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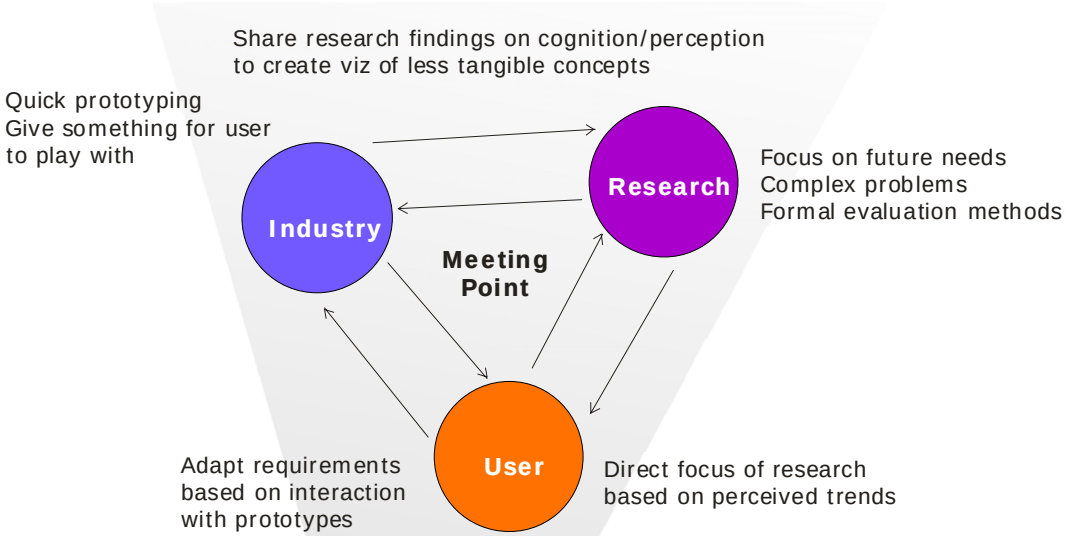
Presented: September 13, 2002

Themes

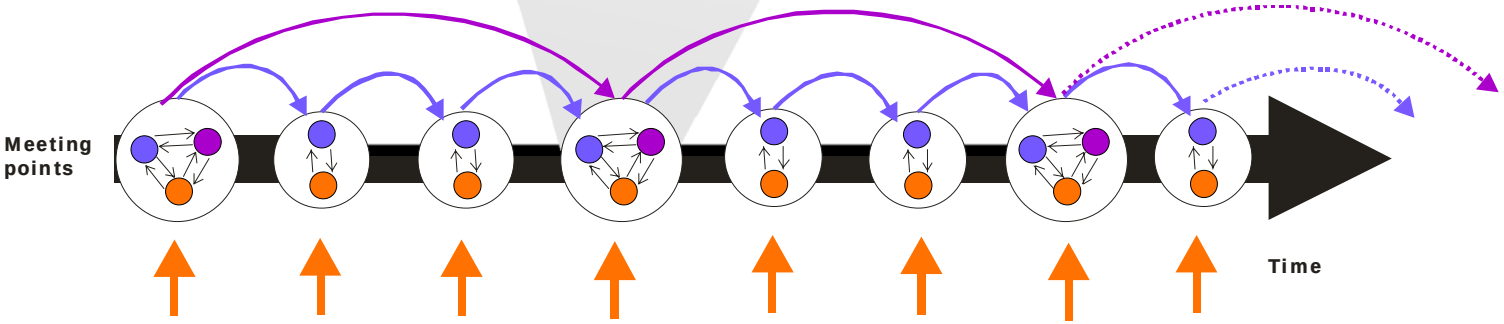
- Advice on work process
- Process Illustration
- Context for presentation techniques needs
- Selected topic
- Other interesting areas of research
- Evaluation/assessment issues

Advice on Work Process

Relationships / Dependencies



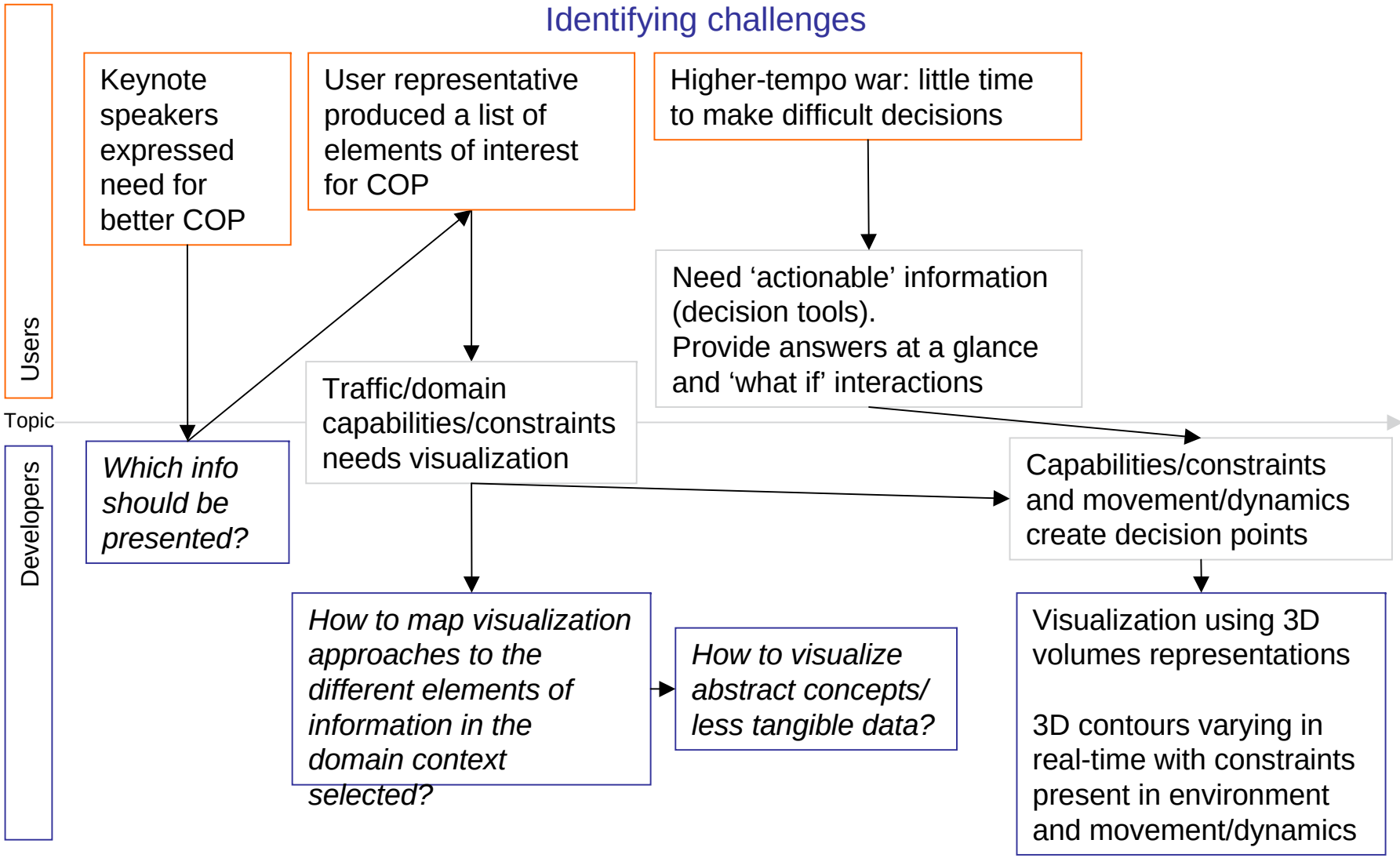
Two parallel roads



Talk between Users and developers

Topic selection Process

Identifying challenges



Mapping

Sensor / Weapons Capabilities / Constraints (Initial attempt, not complete)

Descriptive Aspects

Physical

Range
- Power
- Environment
–- Weather
–- Dust
–- Land Masses
–- Temperature
–- Salinity
–- Depth

Flight Path
Cutouts
Vs. What target?

Less tangible
(abstract, non-spatial, relations, processes)

What is this ship intention?
What does he know?
What can he do?
How reliable is that info?
Is it a threat?
How much risk?
When is the latest time I can switch my sensors on?
If need to effectuate evasive manoeuver, where can I go?

Visualization Approaches

Visual representation

2D maps
3D maps
Graphs
Table / spreadsheet
Organization charts
3D charts (e.g. volumes)
Gantt charts
dashboards
Link analysis
outline/tree view
video
ticker tape
symbology / icons

Visualization enhancements

Overlays
Distortion
Animation

Interaction

Drill down
drag and drop
haptic techniques
drawing
sharing views
control focus (e.g. Dim map)
expand/contract tree view
nav info categories (e.g. Tabs)
hyperlinks

Deployment

Display devices
knowledge wall
multiple displays
table
laptop
handheld
3D stereo
immersive VR

COTS software
portal
spreadsheet
...

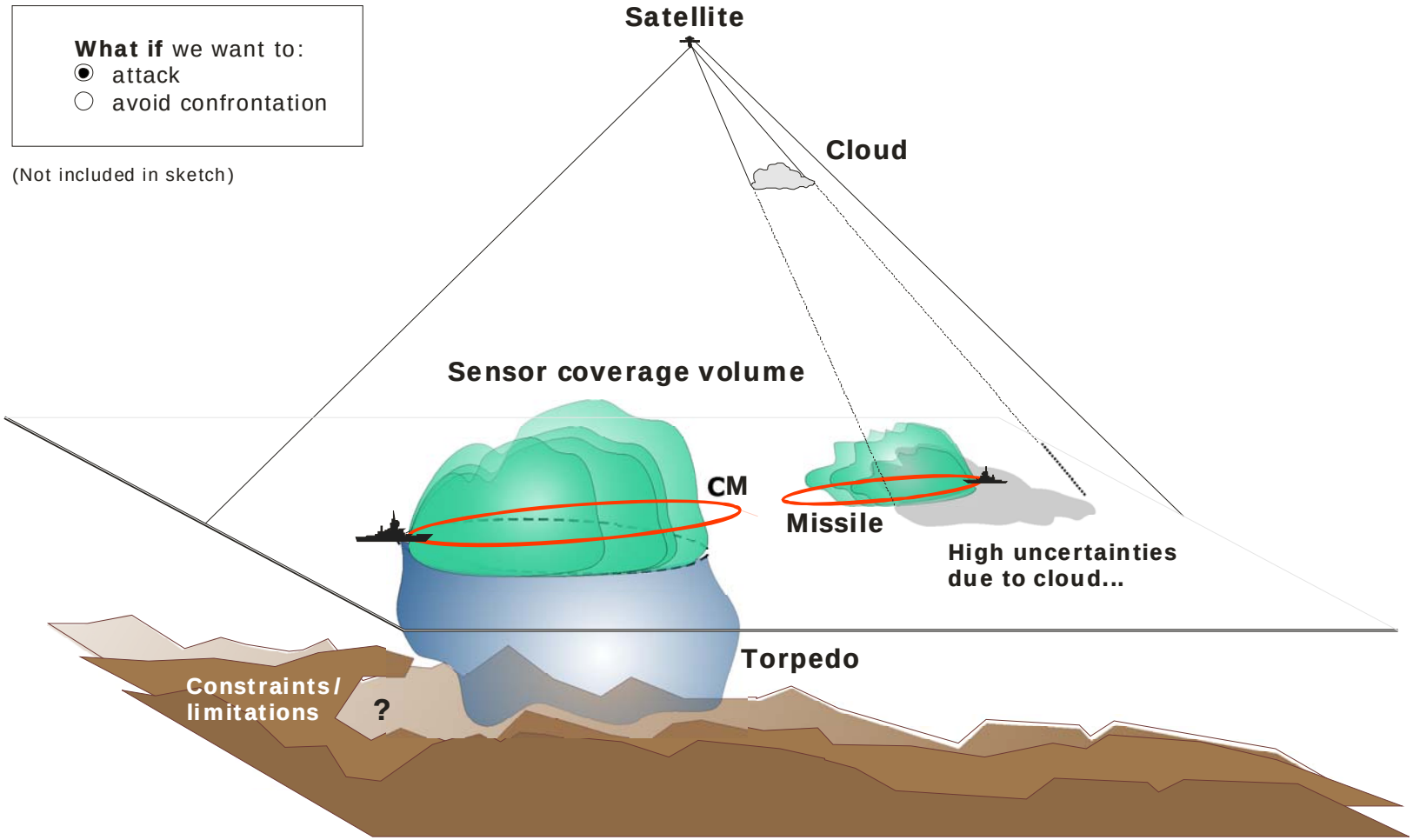
Sensors and weapons capabilities/performance/constraints

- Present sensors and weapons constraints showing 3D contours based on varying parameters values such as
  - Environment (weather, terrain, salinity)
  - Probability of kill
  - Countermeasures
  - Time
- Showing target objects in relation to volume presentation – and volumes in relation to other volumes
  - Answer questions at a glance
  - ‘What if’ interactions
- Optimizing volume presentations

Volumetric presentations

What if we want to:
- (●) attack
- ( ) avoid confrontation

(Not included in sketch)



Areas of Research

- Displaying Levels of Abstraction for various Users
  - "Simplified Land Picture"
- Provide Alternate Modalities
  - Integrate Voice/Chat/Email/Message Traffic
- How "Real" is Necessary?
  - 'Symbicons'
  - When do symbols/graphs work better?
- Automatic Stress/Workload Detection
- Automatic Display of Threats

Evaluation

- Go beyond the HAT report model –
  - Because “cognitive walkthroughs” and comparable methods are NOT good predictors of usability in practice (John’s DARPA project).
- Elaborate on what the system is used for. Develop a representative sample of tasks.
- Develop/agree upon measures of task performance, process as well as ultimate outcome.
- If the system exists –
  - Conduct experimental studies of users performing the sample tasks
    - Reasonable # of users > 10
    - Appropriate prior training before performance measurements
- If the system does not yet exist , but there is a design –
  - Apply cognitive modeling to the sample of tasks (Card, Moran & Newell, Kieras & John)
    - May reveal that task requirements cannot be met (Tomahawk case)
    - Can compare alternative designs (telephone workstation case)
    - Today, somewhat limited scope of what can be modeled